# ENVIRONMENTAL PROTECTION AGENCY WEATHER PROGRAMS

Environmental Protection Agency (EPA) is responsible for working with state, local, and other federal government agencies to provide user-appropriate and scientifically-credible air quality and meteorological programs to support regulatory applications. Applied research and meteorological support are furnished primarily by EPA's National Exposure Research Laboratory and EPA's Office of Air Quality Planning and Standards, both located in Research Triangle Park, North Carolina. This activity is provided through interagency agreements with the National Oceanic and Atmospheric Administration (NOAA), which assigns approximately 50 research meteorologists to the EPA.

Meteorological support to EPA's Office of Research and Development, EPA's Office of Air and Radiation, EPA Regional Offices, and to state and local agencies includes: (1) development and application of air quality dispersion models for pollution control, direct and indirect exposure assessments, and strategy creation; (2) preparation and performance of dispersion studies and air quality model evaluations; and (3) review of meteorological aspects of environmental impact statements, state implementation plans, and pollution variance requests. Meteorological expertise and guidance are also provided for the air quality standard, modeling guideline, and policy development activities of the EPA.

In light of the 1990 Amendments to the Clean Air Act, air quality models and the manner in which they are used are expected to continue to evolve over the next few years. In the area of pollutant deposition, the evaluation of nitrogen, oxidant, sulfur, and aerosol chemistries will help to clarify the roles of model formulation, cloud processes, radiative transfer, and air/surface exchanges in air quality model predictions, leading to a better understanding of model predictions relative to control strategy assessments. Further development and evaluation of existing air quality models will take place to accommodate the inter-pollutant effects resulting from the variety of control programs that are now or may be in place, such as the revisions to the National Ambient Air Quality Standards for ozone and particulate pollution. These inter-pollutant effects include trade-offs among controls on ozone, sulfur oxides, nitrogen oxides, and volatile organic compounds, as well as developing predictable methods of forecasting the impacts on various measures of air quality.

With respect to the inhalable particulate model development, dispersion models are being enhanced to accurately predict aerosol growth from precursors over local and regional transport distances. To assist in the evaluation of the contribution of various sources to regional air degradation, inert tracer and tagged species numerical models have been developed. These models will introduce separate calculations for inert or reactive chemical species emitted from a particular source or region. The calculations will proceed to simulate transport and transformation to a receptor point, where the contribution of emission sources can be discerned.

With respect to oxidant air quality modeling, the roles of biogenic volatile organic compounds, rural nitrogen oxides, and atmospheric transport are being elucidated. A better understanding will be developed of the fundamental aspects of the ozone nonattainment problem, such as differences in urban and rural rates of and/or sources of photochemical production and the interaction through transport of these ozone precursors. Much of this research will be performed under the program previously known as the North American Research Strategy for Tropospheric Ozone, now identified as NARSTO.

Atmospheric research in the areas of climate and climate change includes ozone distribution in the global troposphere, the relationship between ozone distribution and climate (including temporal and spatial aspects), and regional climate studies addressing the interaction of climate with the biosphere. The climatology program involves both analytical and statistical climatology as well as support for regional-scale climate model development. Climate change issues and their feedbacks with the biosphere are being stressed.

Research in human exposure modeling includes microenvironmental monitoring and modeling, and development of exposure assessment tools. Microenvironmental algorithms are being developed based on field data to predict air quality in buildings, attached garages, and street canyons. These improved algorithms are then incorporated into microenvironmental simulation models for conducting human exposure assessments within enclosed spaces in which specific human activities occur. A specific application involves computer graphics-based solar radiation exposure modeling. Three-dimensional graphics modeling software is used to display a near-photographic-quality human model, and to illuminate the model with a simulated sunlight source. Since the American Cancer Society reports that over 80 percent of skin cancers occur on the face, head, neck, and back of the hands, modeling human exposure to solar radiation requires that exposure calculations be anatomically resolved. The calculation of light illumination for various receptor points across the anatomy will provide information about different exposures as a function of model posture, orientation relative to the sun, and sun elevation. This kind of research will provide a "dose" factor needed to develop dose-response functions for skin cancer, immune system suppression, and cataract formation.

In addition to the above major areas, dispersion models for inert, reactive and toxic pollutants are under development and evaluation on all temporal and spatial scales, e.g., indoor, urban, complex terrain, mesoscale, regional, and global. Other efforts include development of air pollution climatologies; modeling of agricultural pesticide spray drift and of fugitive particles from surface coal mines; modeling of trace metal deposition to the Great Lakes, nutrient deposition to Chesapeake Bay, and mercury deposition to the Florida Everglades; modeling of accidental releases of toxic com-

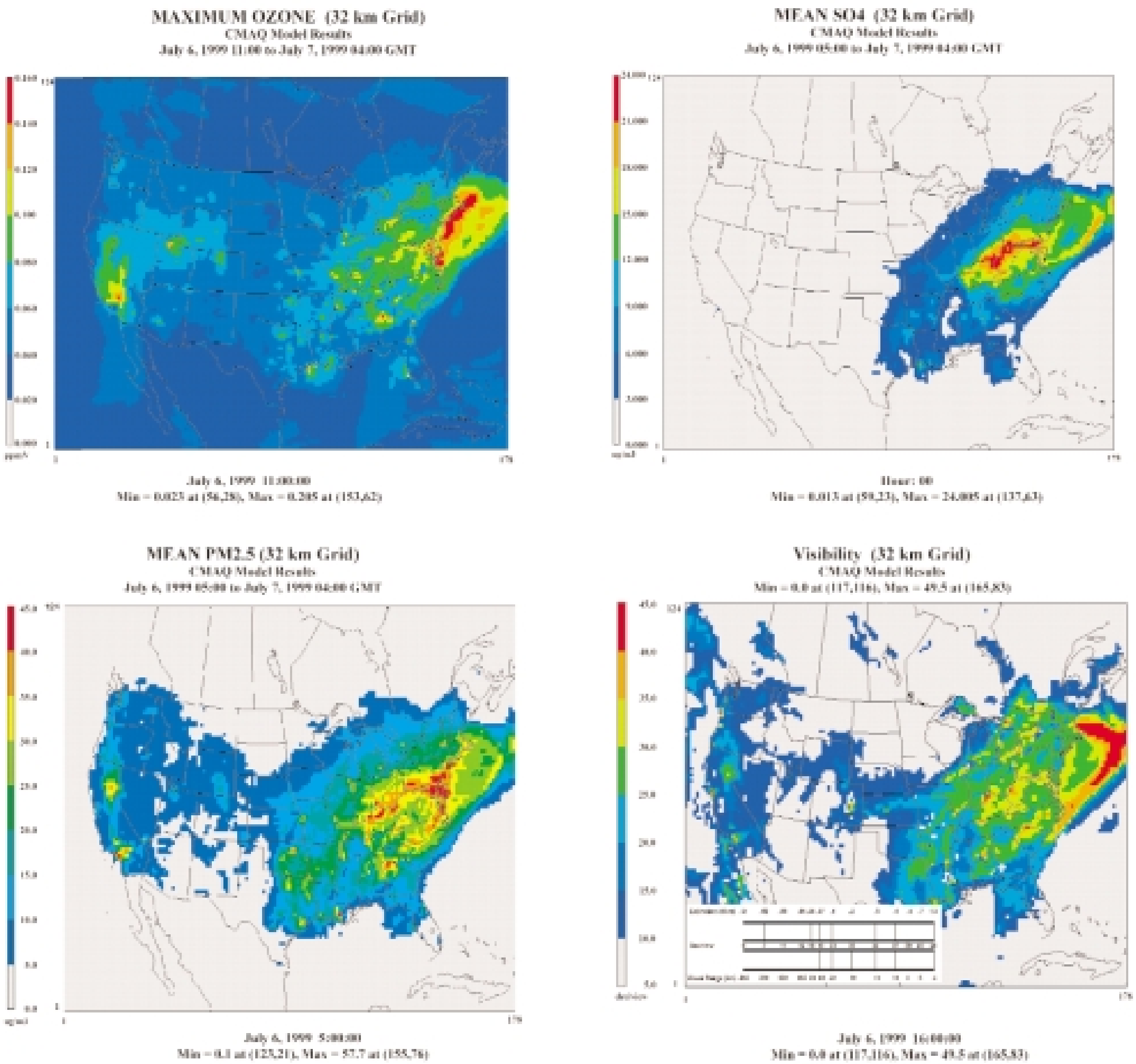


Figure 3-EPA-1. Models-3/CMAQ simulation results for July 6, 1999 for the contiguous United States at 32-km horizontal grid spacing showing: (upper left) maximum 1-hour average ozone concentration (ppmV) in each grid cell between 7:00 AM and midnight EDT; (upper right) 24-hour averages of sulfate concentrations (micrograms/$m^3$); (lower left) 24-hour averages of PM2.5 concentrations (micrograms/$m^3$) in each 32-km grid cell; and (lower right) noontime EDT visibility (deciview, note insert) in each grid cell.

pounds forming dense gas clouds; determination and description of pollutant effects on atmospheric parameters; and conversely, determination of meteorological effects on air quality. Atmospheric flow and dispersion experimental data obtained from wind tunnel, water channel/towing tank, and convection tank experiments in the EPA Fluid Modeling Facility will be used to continue development and evaluation of these models in the FY 2003 period, along with providing researchers with insight into the basic physical processes that affect pollutant dispersion around natural and manmade obstacles. For example, the transport and dispersion of airborne agents in the lower Manhattan, New York area are being simulated in the wind tunnel to evaluate Computational Fluid Dynamics modeling systems in an effort to help build confidence in modeling assessment source-receptor relationships for horrific events such as the one that occurred on September 11, 2001. The convection tank is also being used to simulate and develop improved models for open burning and open detonation of surplus and obsolete military munitions.

Over the past twenty-five years, numerous air quality simulation models have been developed to estimate reductions in ambient air pollutant concentrations resulting from potential emission control strategies. Separate models were developed, for example, for tropospheric ozone and photochemical smog, for acid deposition, and for fine particles. Distinct models also existed for addressing urban scale problems and the larger regional scale problems. It has been recognized, however, that the various pollutant regimes are closely linked chemically, spatially/temporally in the atmosphere. The principal purpose of the Models-3/Community Multi-scale Air Quality (CMAQ) modeling project was to develop a "one atmosphere" flexible environmental modeling tool that integrates the major atmospheric pollution regimes in a multi-scale, multi-pollutant modeling system. This system will enable high-level computational access to both scientific and air quality management users for socio-economic applications in community health assessments and ecosystem sustainability studies.

After seven years of development, the Models-3/CMAQ was released in June 1998 and is being updated annually for use by federal agencies, states, industry, and academia. The latest release occurred in June 2002. It is also intended to serve as a community framework for continual advancement and use of environmental assessment tools. Models-3/CMAQ, configured for the Windows-NT computer system, is available on tapes from the National Technical Information Service (NTIS). It is accompanied by an Installation and Operations Manual, a User Manual, a Science Document, and a Tutorial providing step-by-step instructions for use of the modeling capabilities. Additional information is available at the Models-3 web site at *www.epa.gov/asmdnerl/models3/*. Figure 3-EPA-1 illustrates Models-3/CMAQ simulation results for ozone and fine particulate matter (PM2.5), sulfates, and visibility for July 6, 1999 for the contiguous United States at 32-km horizontal grid dimension, a period of widespread ambient pollution in the nation.

EPA participation in the interagency Information Technology Research and Development (IT R&D) Program is developing a modeling framework that supports integration of diverse models (e.g, atmospheric, land surface, and watershed) as part of EPA's Multimedia Integrated Modeling System (MIMS) project, described at *www.epa.gov/asmdnerl/mims/*. EPA's IT R&D work also enables increased efficiency in air quality meteorological modeling through research on parallel implementation of the CMAQ modeling system.

The evolving MIMS research seeks to improve the environmental management community's ability to evaluate the impact of air quality and watershed management practices, at multiple scales, on stream and estuarine conditions. Toward this goal the primary objectives include (1) developing a prototype multiscale integrated modeling system with predictive meteorological capability for transport and fate of nutrients and chemical stressors; (2) enabling the use of remotely sensed meteorological data; and 3) developing a computer-based problem solving environment with ready access to data, models, and integrated visualization and analysis tools for water and air quality management, local and regional development planning, and exposure-risk assessments. Under the MIMS project, a variety of research areas are being pursued such as the integration of the National Weather Service Next Generation Radar (NEXRAD) Stage IV data into watershed modeling applications; enhanced atmospheric dry deposition models; multi-scale, spatially explicit watershed modeling tools; and model-coupling technology for integrating media specific models. The MIMS development extends the open architecture approach demonstrated in the third generation modeling system, Models-3/CMAQ, and is the next generation of modeling frameworks under the IT R&D program.

EPA also maintains relations with foreign countries to facilitate exchange of research meteorologists and research results pertaining to meteorological aspects of air pollution. For example, agreements are currently in place with Canada, Japan, Korea, China, and Mexico, and with several European countries under the NATO Committee on the Challenges of Modern Society (CCMS).